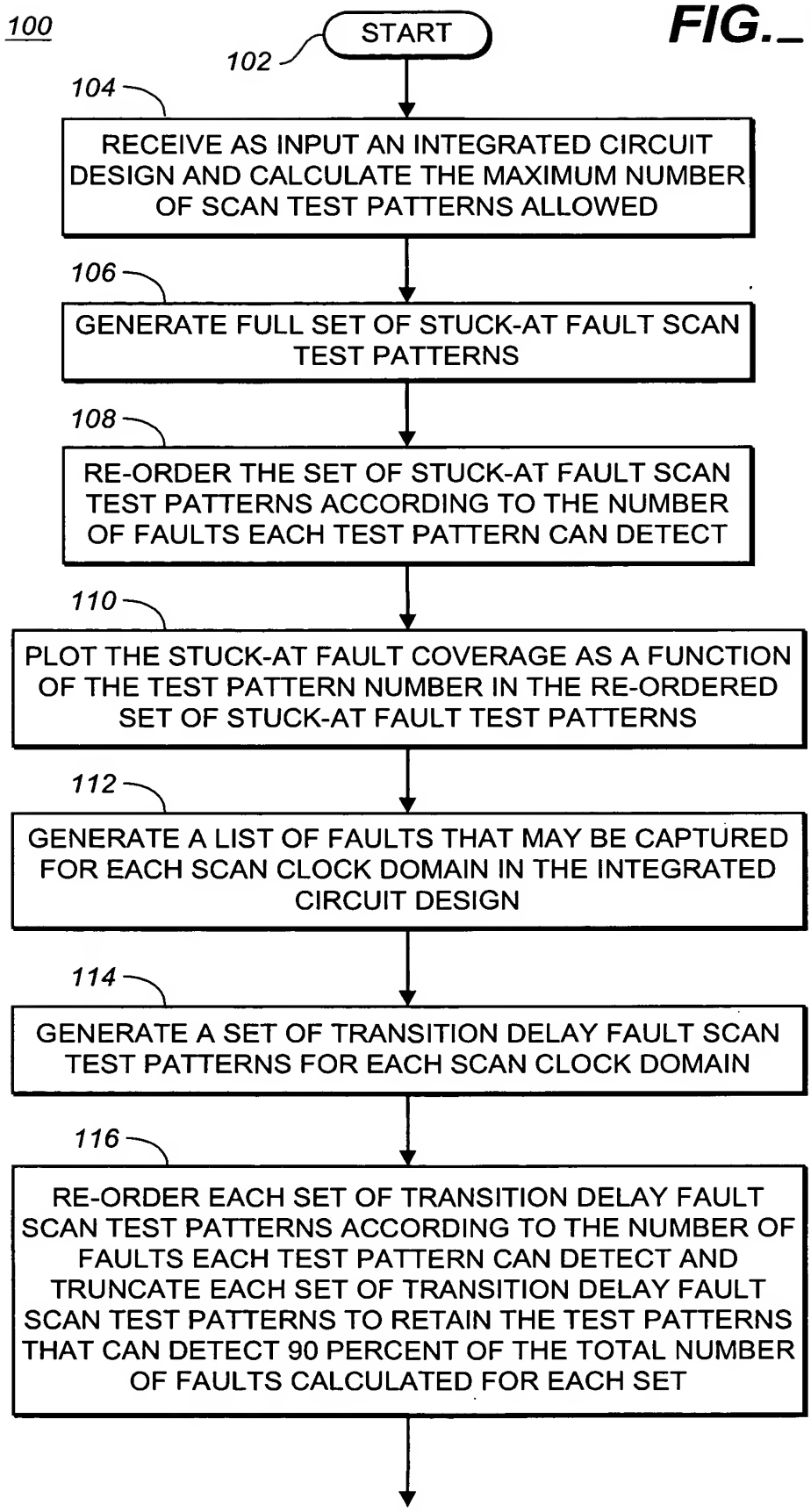

100
START
102
104
RECEIVE AS INPUT AN INTEGRATED CIRCUIT DESIGN AND CALCULATE THE MAXIMUM NUMBER OF SCAN TEST PATTERNS ALLOWED
106
GENERATE FULL SET OF STUCK-AT FAULT SCAN TEST PATTERNS
108
RE-ORDER THE SET OF STUCK-AT FAULT SCAN TEST PATTERNS ACCORDING TO THE NUMBER OF FAULTS EACH TEST PATTERN CAN DETECT
110
PLOT THE STUCK-AT FAULT COVERAGE AS A FUNCTION OF THE TEST PATTERN NUMBER IN THE RE-ORDERED SET OF STUCK-AT FAULT TEST PATTERNS
112
GENERATE A LIST OF FAULTS THAT MAY BE CAPTURED FOR EACH SCAN CLOCK DOMAIN IN THE INTEGRATED CIRCUIT DESIGN
114
GENERATE A SET OF TRANSITION DELAY FAULT SCAN TEST PATTERNS FOR EACH SCAN CLOCK DOMAIN
116
RE-ORDER EACH SET OF TRANSITION DELAY FAULT SCAN TEST PATTERNS ACCORDING TO THE NUMBER OF FAULTS EACH TEST PATTERN CAN DETECT AND TRUNCATE EACH SET OF TRANSITION DELAY FAULT SCAN TEST PATTERNS TO RETAIN THE TEST PATTERNS THAT CAN DETECT 90 PERCENT OF THE TOTAL NUMBER OF FAULTS CALCULATED FOR EACH SET

FIG._1A

FIG._1B

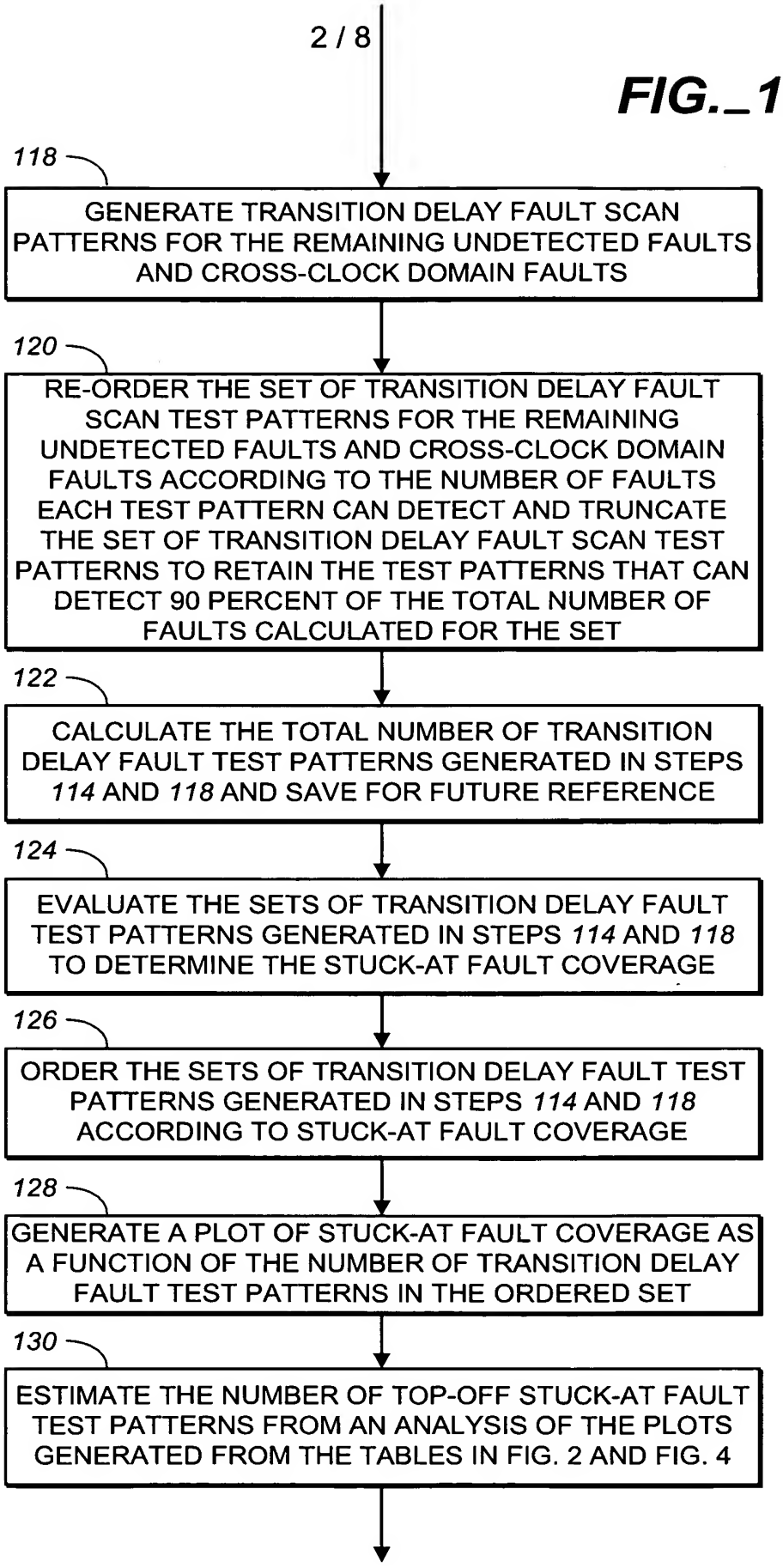
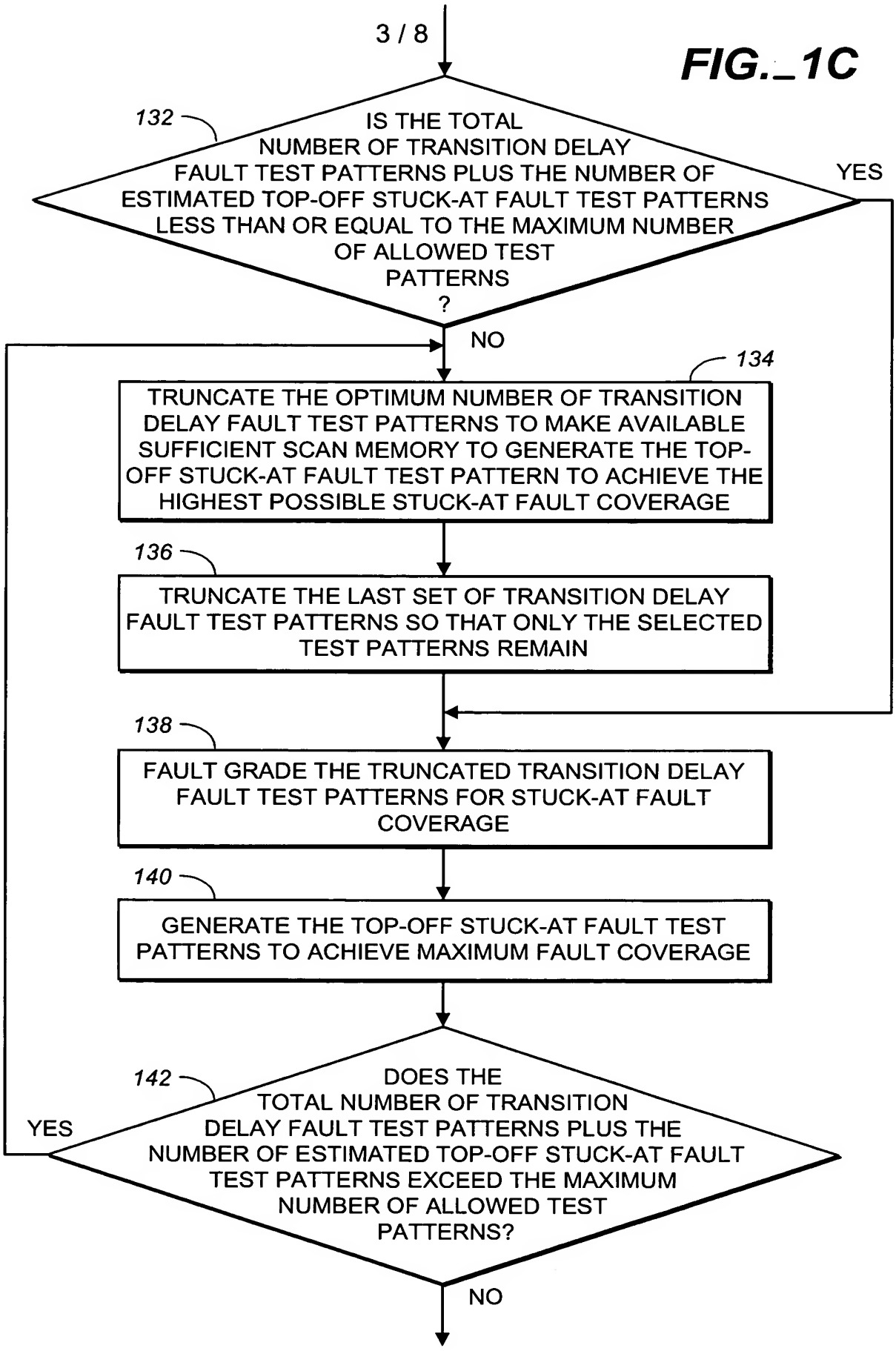

118
GENERATE TRANSITION DELAY FAULT SCAN PATTERNS FOR THE REMAINING UNDETECTED FAULTS AND CROSS-CLOCK DOMAIN FAULTS
120
RE-ORDER THE SET OF TRANSITION DELAY FAULT SCAN TEST PATTERNS FOR THE REMAINING UNDETECTED FAULTS AND CROSS-CLOCK DOMAIN FAULTS ACCORDING TO THE NUMBER OF FAULTS EACH TEST PATTERN CAN DETECT AND TRUNCATE THE SET OF TRANSITION DELAY FAULT SCAN TEST PATTERNS TO RETAIN THE TEST PATTERNS THAT CAN DETECT 90 PERCENT OF THE TOTAL NUMBER OF FAULTS CALCULATED FOR THE SET
122
CALCULATE THE TOTAL NUMBER OF TRANSITION DELAY FAULT TEST PATTERNS GENERATED IN STEPS 114 AND 118 AND SAVE FOR FUTURE REFERENCE
124
EVALUATE THE SETS OF TRANSITION DELAY FAULT TEST PATTERNS GENERATED IN STEPS 114 AND 118 TO DETERMINE THE STUCK-AT FAULT COVERAGE
126
ORDER THE SETS OF TRANSITION DELAY FAULT TEST PATTERNS GENERATED IN STEPS 114 AND 118 ACCORDING TO STUCK-AT FAULT COVERAGE
128
GENERATE A PLOT OF STUCK-AT FAULT COVERAGE AS A FUNCTION OF THE NUMBER OF TRANSITION DELAY FAULT TEST PATTERNS IN THE ORDERED SET
130
ESTIMATE THE NUMBER OF TOP-OFF STUCK-AT FAULT TEST PATTERNS FROM AN ANALYSIS OF THE PLOTS GENERATED FROM THE TABLES IN FIG. 2 AND FIG. 4

FIG._1C


132
IS THE TOTAL NUMBER OF TRANSITION DELAY FAULT TEST PATTERNS PLUS THE NUMBER OF ESTIMATED TOP-OFF STUCK-AT FAULT TEST PATTERNS LESS THAN OR EQUAL TO THE MAXIMUM NUMBER OF ALLOWED TEST PATTERNS ?
YES
NO
134
TRUNCATE THE OPTIMUM NUMBER OF TRANSITION DELAY FAULT TEST PATTERNS TO MAKE AVAILABLE SUFFICIENT SCAN MEMORY TO GENERATE THE TOP-OFF STUCK-AT FAULT TEST PATTERN TO ACHIEVE THE HIGHEST POSSIBLE STUCK-AT FAULT COVERAGE
136
TRUNCATE THE LAST SET OF TRANSITION DELAY FAULT TEST PATTERNS SO THAT ONLY THE SELECTED TEST PATTERNS REMAIN
138
FAULT GRADE THE TRUNCATED TRANSITION DELAY FAULT TEST PATTERNS FOR STUCK-AT FAULT COVERAGE
140
GENERATE THE TOP-OFF STUCK-AT FAULT TEST PATTERNS TO ACHIEVE MAXIMUM FAULT COVERAGE
142
DOES THE TOTAL NUMBER OF TRANSITION DELAY FAULT TEST PATTERNS PLUS THE NUMBER OF ESTIMATED TOP-OFF STUCK-AT FAULT TEST PATTERNS EXCEED THE MAXIMUM NUMBER OF ALLOWED TEST PATTERNS?
YES
NO

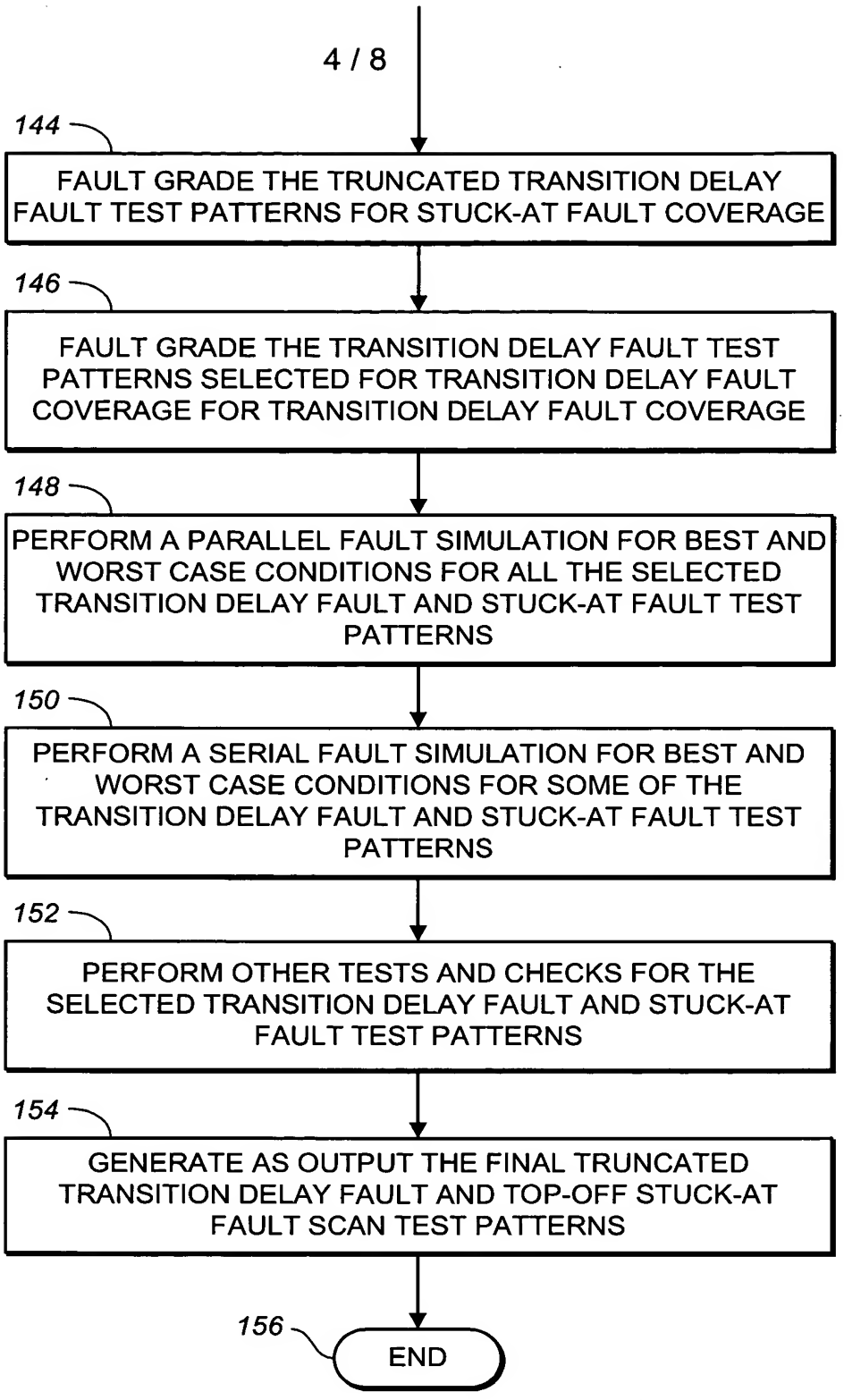

144
FAULT GRADE THE TRUNCATED TRANSITION DELAY FAULT TEST PATTERNS FOR STUCK-AT FAULT COVERAGE
146
FAULT GRADE THE TRANSITION DELAY FAULT TEST PATTERNS SELECTED FOR TRANSITION DELAY FAULT COVERAGE FOR TRANSITION DELAY FAULT COVERAGE
148
PERFORM A PARALLEL FAULT SIMULATION FOR BEST AND WORST CASE CONDITIONS FOR ALL THE SELECTED TRANSITION DELAY FAULT AND STUCK-AT FAULT TEST PATTERNS
150
PERFORM A SERIAL FAULT SIMULATION FOR BEST AND WORST CASE CONDITIONS FOR SOME OF THE TRANSITION DELAY FAULT AND STUCK-AT FAULT TEST PATTERNS
152
PERFORM OTHER TESTS AND CHECKS FOR THE SELECTED TRANSITION DELAY FAULT AND STUCK-AT FAULT TEST PATTERNS
154
GENERATE AS OUTPUT THE FINAL TRUNCATED TRANSITION DELAY FAULT AND TOP-OFF STUCK-AT FAULT SCAN TEST PATTERNS
156
END

FIG._1D

200

32 50.71% 4179	1088 92.37% 3123	2144 95.97% 2067	3200 97.14% 1011
64 60.29% 4147	1120 92.55% 3091	2176 96.02% 2035	3232 97.17% 979
96 65.85% 4115	1152 92.77% 3059	2208 96.08% 2003	3264 97.20% 947
128 69.67% 4083	1184 92.93% 3027	2240 96.14% 1971	3296 97.22% 915
160 73.00% 4051	1216 93.12% 2995	2272 96.17% 1939	3328 97.23% 883
192 75.47% 4019	1248 93.27% 2963	2304 96.23% 1907	3360 97.24% 851
224 77.42% 3987	1280 93.43% 2931	2336 96.27% 1875	3392 97.25% 819
256 78.96% 3955	1312 93.57% 2899	2368 96.31% 1843	3424 97.26% 787
288 80.22% 3923	1344 93.73% 2867	2400 96.36% 1811	3456 97.28% 755
320 81.37% 3891	1376 93.86% 2835	2432 96.41% 1779	3488 97.29% 723
352 82.30% 3859	1408 93.97% 2803	2464 96.45% 1747	3520 97.30% 691
384 83.22% 3827	1440 94.09% 2771	2496 96.49% 1715	3552 97.32% 659
416 84.04% 3795	1472 94.21% 2739	2528 96.56% 1683	3584 97.33% 627
448 84.86% 3763	1504 94.31% 2707	2560 96.61% 1651	3616 97.34% 595
480 85.55% 3731	1536 94.41% 2675	2592 96.64% 1619	3648 97.35% 563
512 86.24% 3699	1568 94.52% 2643	2624 96.67% 1587	3680 97.35% 531
544 86.79% 3667	1600 94.61% 2611	2656 96.71% 1555	3712 97.36% 499
576 87.29% 3635	1632 94.72% 2579	2688 96.75% 1523	3744 97.37% 467
608 87.84% 3603	1664 94.82% 2547	2720 96.78% 1491	3776 97.37% 435
640 88.30% 3571	1696 94.90% 2515	2752 96.80% 1459	3808 97.38% 403
672 88.68% 3539	1728 95.00% 2483	2784 96.84% 1427	3840 97.39% 371
704 89.08% 3507	1760 95.09% 2451	2816 96.87% 1395	3872 97.39% 339
736 89.47% 3475	1792 95.18% 2419	2848 96.90% 1363	3904 97.40% 307
768 89.85% 3443	1824 95.27% 2387	2880 96.92% 1331	3936 97.41% 275
800 90.18% 3411	1856 95.34% 2355	2912 96.94% 1299	3968 97.42% 243
832 90.51% 3379	1888 95.43% 2323	2944 96.96% 1267	4000 97.42% 211
864 90.76% 3347	1920 95.51% 2291	2976 97.00% 1235	4032 97.43% 179
896 91.03% 3315	1952 95.58% 2259	3008 97.03% 1203	4064 97.43% 147
928 91.30% 3283	1984 95.66% 2227	3040 97.05% 1171	4096 97.44% 115
960 91.51% 3251	2016 95.73% 2195	3072 97.06% 1139	4128 97.44% 83
992 91.76% 3219	2048 95.79% 2163	3104 97.08% 1107	4160 97.45% 51
1024 91.95% 3187	2080 95.86% 2131	3136 97.10% 1075	4192 97.45% 19
1056 92.16% 3155	2112 95.91% 2099	3168 97.12% 1043	4211 97.45% 0

FIG._2

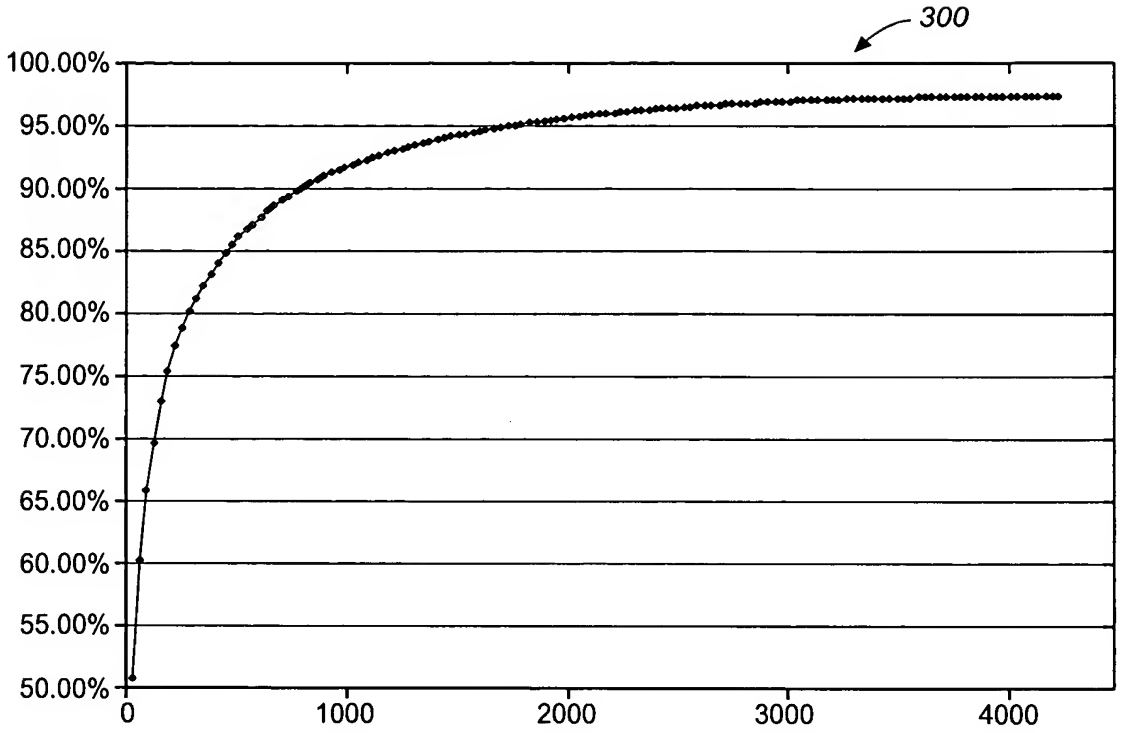

300
100.00%
95.00%
90.00%
85.00%
80.00%
75.00%
70.00%
65.00%
60.00%
55.00%
50.00%
0
1000
2000
3000
4000

FIG._3

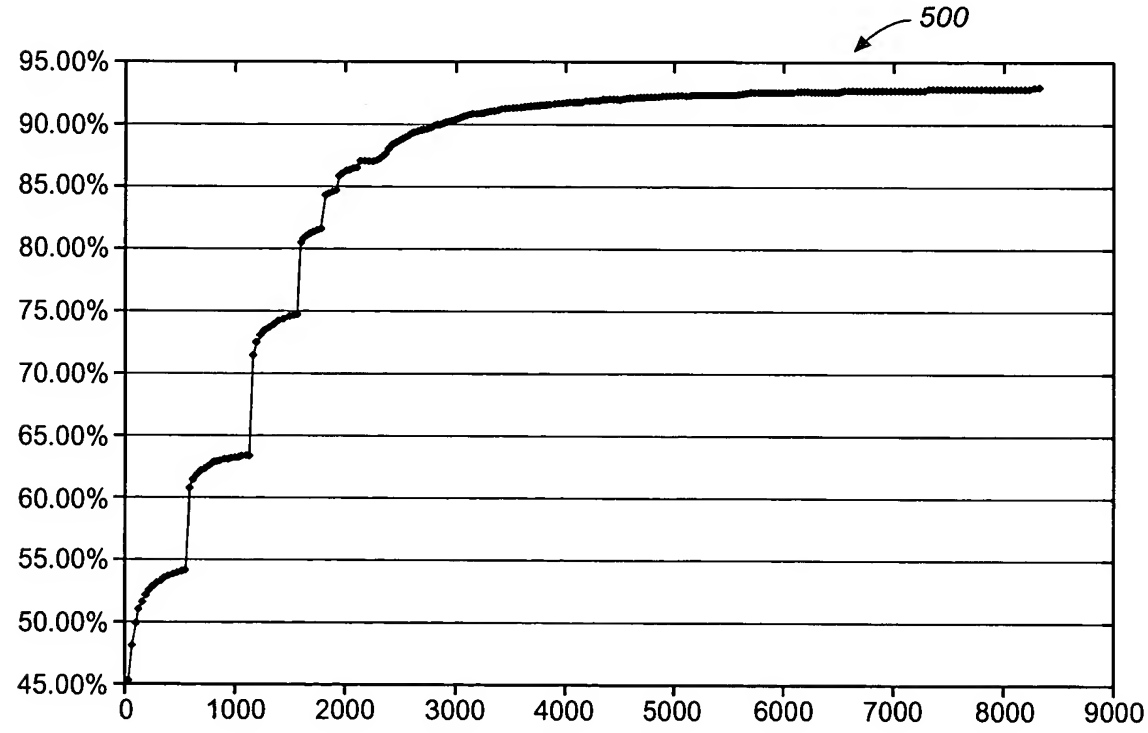

500
95.00%
90.00%
85.00%
80.00%
75.00%
70.00%
65.00%
60.00%
55.00%
50.00%
45.00%
0
1000
2000
3000
4000
5000
6000
7000
8000
9000

FIG._5

400

32	45.22%	6968	2123	86.98%	4877	4194	91.70%	2806	6306	92.46%	694
64	48.01%	6936	2155	86.99%	4845	4226	91.71%	2774	6338	92.46%	662
96	49.80%	6904	2187	87.00%	4813	4258	91.76%	2742	6370	92.47%	630
128	50.92%	6872	2219	87.00%	4781	4290	91.78%	2710	6402	92.48%	598
160	51.48%	6840	2251	87.00%	4749	4322	91.80%	2678	6434	92.48%	566
192	52.09%	6808	2283	87.36%	4717	4354	91.82%	2646	6466	92.49%	534
224	52.54%	6776	2315	87.38%	4685	4386	91.84%	2614	6498	92.49%	502
256	52.79%	6744	2334	87.38%	4666	4418	91.85%	2582	6530	92.50%	470
288	53.02%	6712	2362	87.90%	4638	4450	91.87%	2550	6562	92.50%	438
320	53.18%	6680	2370	88.02%	4630	4482	91.88%	2518	6594	92.51%	406
352	53.47%	6648	2402	88.20%	4598	4514	91.91%	2486	6626	92.51%	374
384	53.61%	6616	2434	88.36%	4566	4546	91.92%	2454	6658	92.52%	342
416	53.71%	6584	2466	88.54%	4534	4578	91.93%	2422	6690	92.52%	310
448	53.84%	6552	2498	88.73%	4502	4610	91.94%	2390	6722	92.52%	278
480	53.95%	6520	2530	88.87%	4470	4642	91.96%	2358	6754	92.52%	246
512	54.02%	6488	2562	89.01%	4438	4674	91.97%	2326	6786	92.53%	214
544	54.09%	6456	2594	89.16%	4406	4706	91.98%	2294	6818	92.53%	182
576	60.68%	6424	2626	89.31%	4374	4738	92.00%	2262	6850	92.54%	150
608	61.41%	6392	2658	89.41%	4342	4770	92.01%	2230	6882	92.54%	118
640	61.82%	6360	2690	89.55%	4310	4802	92.02%	2198	6914	92.55%	86
672	62.11%	6328	2722	89.66%	4278	4834	92.03%	2166	6946	92.55%	54
704	62.30%	6296	2754	89.76%	4246	4866	92.04%	2134	6978	92.56%	22
736	62.50%	6264	2786	89.85%	4214	4898	92.04%	2102	7010	92.56%	-10
768	62.65%	6232	2818	89.92%	4182	4930	92.05%	2070	7042	92.57%	-42
800	62.78%	6200	2850	90.01%	4150	4962	92.06%	2038	7074	92.58%	-74
832	62.85%	6168	2882	90.10%	4118	4994	92.08%	2006	7106	92.59%	-106
864	62.93%	6136	2914	90.18%	4086	5026	92.09%	1974	7138	92.60%	-138
896	63.01%	6104	2946	90.25%	4054	5058	92.10%	1942	7170	92.60%	-170
928	63.09%	6072	2978	90.33%	4022	5090	92.11%	1910	7202	92.61%	-202
960	63.14%	6040	3010	90.39%	3990	5122	92.13%	1878	7234	92.61%	-234
992	63.18%	6008	3042	90.47%	3958	5154	92.15%	1846	7266	92.61%	-266
1024	63.23%	5976	3074	90.52%	3926	5186	92.15%	1814	7298	92.62%	-298
1056	63.25%	5944	3106	90.59%	3894	5218	92.16%	1782	7330	92.62%	-330
1088	63.28%	5912	3138	90.64%	3862	5250	92.17%	1750	7362	92.62%	-362
1120	63.31%	5880	3170	90.70%	3830	5282	92.18%	1718	7394	92.62%	-394
1152	71.29%	5848	3202	90.74%	3798	5314	92.18%	1686	7426	92.63%	-426
1184	72.36%	5816	3234	90.78%	3766	5346	92.19%	1654	7458	92.63%	-458
1216	72.93%	5784	3266	90.83%	3734	5378	92.20%	1622	7490	92.63%	-490
1248	73.31%	5752	3298	90.89%	3702	5410	92.21%	1590	7522	92.64%	-522
1280	73.59%	5720	3330	90.93%	3670	5442	92.22%	1558	7554	92.65%	-554
1312	73.81%	5688	3362	90.97%	3638	5474	92.23%	1526	7586	92.65%	-586
1344	74.01%	5656	3394	91.02%	3606	5506	92.24%	1494	7618	92.65%	-618
1376	74.14%	5624	3426	91.05%	3574	5538	92.25%	1462	7650	92.66%	-650

FIG._4A

1408	74.26%	5592	3458	91.08%	3542	5570	92.26%	1430	7682	92.66%	-682
1440	74.35%	5560	3490	91.13%	3510	5602	92.27%	1398	7714	92.66%	-714
1472	74.45%	5528	3522	91.17%	3478	5634	92.28%	1366	7746	92.67%	-746
1504	74.53%	5496	3554	91.20%	3446	5666	92.29%	1334	7778	92.67%	-778
1536	74.60%	5464	3586	91.23%	3414	5698	92.29%	1302	7810	92.67%	-810
1568	80.41%	5432	3618	91.26%	3382	5730	92.30%	1270	7842	92.68%	-842
1600	80.89%	5400	3650	91.29%	3350	5762	92.31%	1238	7874	92.68%	-874
1632	81.13%	5368	3682	91.33%	3318	5794	92.31%	1206	7906	92.68%	-906
1664	81.28%	5336	3714	91.35%	3286	5826	92.32%	1174	7938	92.69%	-938
1696	81.39%	5304	3746	91.38%	3254	5858	92.32%	1142	7970	92.69%	-970
1728	81.48%	5272	3778	91.42%	3222	5890	92.33%	1110	8002	92.69%	-1002
1760	81.55%	5240	3810	91.44%	3190	5922	92.34%	1078	8034	92.70%	-1034
1792	84.11%	5208	3842	91.46%	3158	5954	92.34%	1046	8066	92.70%	-1066
1824	84.37%	5176	3874	91.49%	3126	5986	92.34%	1014	8098	92.70%	-1098
1856	84.51%	5144	3906	91.51%	3094	6018	92.35%	982	8130	92.71%	-1130
1888	84.59%	5112	3938	91.54%	3062	6050	92.35%	950	8162	92.71%	-1162
1920	85.79%	5080	3970	91.56%	3030	6082	92.36%	918	8194	92.72%	-1194
1952	86.07%	5048	4002	91.58%	2998	6114	92.41%	886	8226	92.72%	-1226
1984	86.22%	5016	4034	91.61%	2966	6146	92.42%	854	8258	92.73%	-1258
2016	86.31%	4984	4066	91.62%	2934	6178	92.43%	822	8290	92.73%	-1290
2048	86.38%	4952	4098	91.64%	2902	6210	92.44%	790			
2080	86.43%	4920	4130	91.66%	2870	6242	92.44%	758			
2112	86.93%	4888	4162	91.68%	2838	6274	92.45%	726			

FIG._4B